MODELING RAPID CHARGE CONDITIONS IN A VRLA TRACTION BATTERY

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Rapid charge promises attractive benefits to electric and hybrid vehicle applications. Using rapid charging, we not only can enjoy reduced charging time, increased utilization of the battery energy, enhanced mobility, but also other potential benefits such as increased battery cycle life and reduced overall ownership costs.

Work presented in this paper looks to examine underlying transport and reaction limiting mechanisms under constant current rapid charge conditions using a recently developed multiphase, electrochemical and thermal coupled model. As accurate predictions from the simulation strongly rely on careful validation of the numerical model and the parameters used, both single cell and commercial modules were tested under the same charging rates examined with the simulation. Based upon good correlation of macroscopic parameters such as voltage, temperature, pressure, and electrode potentials, confidence in the simulation's ability to predict such processes as the species transported by diffusion, convection and migration under rapid charge is enhanced. We were able to look into the limiting mechanism to decipher if reaction or transport is limiting the process. This is the advantage of involving modeling and simulation in the rapid charge development.

With an improved understanding of the fundamental electrochemical and transport processes involved in rapid charging, an optimized charging algorithm or battery design can be developed efficiently, avoiding extensive laboratory testing. For example, an adaptive charging algorithm may result from the charge termination conditions determined from the simulation in line with the actual charging process to provide a safeguard for a proper charge execution.

Acknowledgements

The authors would like to thank DARPA and Hawaii Electric Vehicle Demonstration Project (HEVDP) for supporting this work under the Federal Cooperative Agreement MDA972-95-0009. The authors would also like to thank C.Y. Wang and his co-workers for their assistances in developing the simulation code.

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